

INCH-POUND

NOTE: The document identifier and heading have been changed on this page to reflect that this is a performance specification. There are no other changes to this document. The document identifier on subsequent pages has not been changed, but will be changed the next time this document is revised.

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SUPERSEDING  
MIL-C-83421A  
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#### PERFORMANCE SPECIFICATION

#### CAPACITORS, FIXED, METALLIZED, PLASTIC FILM DIELECTRIC, (DC, AC, OR DC AND AC), HERMETICALLY SEALED IN METAL OR CERAMIC CASES, ESTABLISHED RELIABILITY, GENERAL SPECIFICATION FOR

This specification is approved for use by all Departments and Agencies of the Department of Defense.

#### 1. SCOPE

1.1 Scope. This specification covers the general requirements for established reliability, metallized plastic film dielectric, fixed capacitors, hermetically sealed in metal or ceramic cases. Capacitors covered by this specification have failure rate (FR) levels established in accordance with MIL-STD-690. The reliability for each level is identified by a symbol in accordance with table 1. These FR levels are established at a 90 percent confidence level and maintained at a 10 percent producer's risk and, unless otherwise specified (see 3.1), are based on life tests performed at maximum rated voltage at maximum rated temperature. Unless otherwise specified (see 3.1), an acceleration factor of 5:1 has been used to relate life-test data obtained at 140 percent of rated voltage at maximum rated temperature, to rated voltage at rated temperature (see 6.2). A part per million (PPM) quality system is used for documenting and reporting the average outgoing quality of capacitors supplied to this specification. Statistical process control (SPC) techniques are required in the manufacturing process to minimize variation in production of capacitors supplied to the requirements of this specification.

TABLE 1. FR level (established at a 90 percent confidence level).

Symbol	FR level
	<u>Percent/1,000 hour</u>
M	1.0
P	0.1
R	0.01
S	0.001

1.2 Classification. Capacitors covered by this specification are classified by the style, as specified (see 3.1).

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Defense Electronics Supply Center, ATTN: DESC-ELDM, 1507 Wilmington Pike, Dayton, OH 45444-5765, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A

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FSC 5910

## 2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

## SPECIFICATIONS

## FEDERAL

QQ-S-571 - Solder; Tin Alloy; Tin-Lead Alloy; and Lead Alloy.

## MILITARY

MIL-C-39022/9 - Capacitors, Fixed, Metallized Plastic Film Dielectric, Direct and Alternating Current, (Hermetically Sealed in Metal Cases), Established Reliability, Styles CHRO1A, CHRO1B, CHRO1C, CHRO1D, CHRO1E, CHRO1F, CHRO1G, CHRO1H, CHRO1J, CHRO1K, CHRO1L, CHRO1M, CHRO1N, CHRO1P, and CHRO1R (Insulated).

MIL-C-39028 - Capacitors, Packaging of.

MIL-C-83421/1 - Capacitors, Fixed, Metallized Plastic Film, Dielectric, DC and AC, Hermetically Sealed in Metal Cases, Established Reliability, Styles CRH01, CRH02, CRH03, CRH04, CRH05, CRH06, CRH07, CRH08, CRH09, and CRH00.

MIL-C-83421/2 - Capacitors, Fixed, Metallized Plastic Film, Dielectric, (DC, AC, or DC and AC), Hermetically Sealed in Metal Cases, Established Reliability, Styles CRH11, CRH12, and CRH13 (Insulated).

MIL-C-83421/3 - Capacitors, Fixed, Metallized Plastic Film Dielectric, DC and AC, Hermetically Sealed in Metal Cases, High Reliability (Insulated), Styles CRS01, CRS02, and CRS03, CRS04 and CRS05.

MIL-C-83421/4 - Capacitors, Fixed, Metallized Plastic Film Dielectric, (DC, AC, or DC and AC), Hermetically Sealed in Metal Cases, High Reliability (Insulated), Styles CRS11, CRS12 and CRS13.

MIL-C-83421/5 - Capacitors, Fixed, Metallized Plastic Film Dielectric, (DC, AC, or DC and AC), Hermetically Sealed in Ceramic Cases, Established Reliability, Styles CRH21, CRH22, CRH23, CRH24 and CRH25.

MIL-C-87217 - Capacitors, Fixed, Supermetallized Plastic Film Dielectric, Direct Current For Low Energy, High Impedance Applications, Hermetically Sealed in Metal Cases, High Reliability, General Specification For.

## STANDARDS

## MILITARY

- MIL-STD-202 - Test Methods for Electronic and Electrical Component Parts
- MIL-STD-690 - Failure Rate Sampling Plans and Procedures.
- MIL-STD-790 - Reliability Assurance Program for Electronic Parts Specifications.
- MIL-STD-810 - Environmental Test Methods and Engineering Guidelines.
- MIL-STD-1276 - Leads for Electronic Component Parts.
- MIL-STD-1285 - Marking of Electrical and Electronic Parts.

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

**2.2 Non-Government publications.** The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation (see 6.2).

## ELECTRONIC INDUSTRIES ASSOCIATION (EIA)

- EIA-554 - Assessment of Outgoing Nonconforming Levels in Parts Per Million (PPM).
- EIA-557 - Statistical Process Control Systems.

(Application for copies should be addressed to the Electronic Industries Association, 2001 Eye Street, NW, Washington, DC 20006.)

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- ASTM D92 - Standard Test Method for Flash and Fire Points by Cleveland Open Cup.

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

**2.3 Order of precedence.** In the event of a conflict between the text of this document and the references cited herein (except for related associated detail specifications, specification sheets, or MS standards), the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

### 3. REQUIREMENTS

3.1 Specification sheets. The individual item requirements shall be as specified herein and in accordance with the applicable specification sheets. In the event of any conflict between requirements of this specification and the specification sheets, the latter shall govern (see 4.7.1).

3.2 Qualification. Capacitors furnished under this specification shall be products which are qualified for listing on the applicable qualified products list at the time set for opening of bids (see 4.4 and 6.4). In addition, the manufacturer shall obtain certification from the qualifying activity that the reliability assurance requirements of 4.1.1 have been met and are being maintained. Unless acquired from the manufacturer or his authorized distributor listed or approved for listing on the qualified products list, parts furnished under this specification shall not be considered as having met the requirements of this specification.

### 3.3 Reliability and quality.

3.3.1 Reliability. Reliability of capacitors furnished under this specification shall be established and maintained in accordance with the procedures and requirements specified in MIL-STD-790 and MIL-STD-690 with details specified in 4.1.2, 4.4.4, and 4.5.

### 3.3.2 Quality.

3.3.2.1 Statistical process control. The contractor shall implement and use statistical process control techniques in the manufacturing process for parts covered by this specification. The SPC program shall be developed and maintained in accordance with all the requirements of EIA-557. The SPC program shall be documented and maintained as part of the overall reliability assurance program as specified in MIL-STD-790. The implementation of statistical process control shall be 12 months from the date of this specification. Processes for application of SPC techniques should include but are not limited to:

- a. Pre-assembly.
- b. Assembly.
- c. Encapsulation.
- d. Packaging.

3.3.2.2 Quality levels. The quality of lots that have been subject to and passed the subgroup 100 percent screening inspection of the group A inspection shall be established and maintained in accordance with 4.4.4.2 and EIA-554. Individual PPM defect level (i.e., PPM-2 and PPM-3) and an overall PPM defect level (i.e., PPM-5) shall be established based on the tests prescribed in the subgroup 2 tests of the group A inspections. The defect level for PPM-2 shall be less than 100 PPM. The implementation of PPM verification shall be 12 months from the date of this specification.

3.3.2.2.1 Noncompliance. The contractor shall notify the qualifying activity when the 100 PPM level is reached or exceeded for PPM-2. The contractor shall provide sufficient information to the qualifying activity documenting the causes of the problem and what corrective action is being taken. Failure to correct this problem shall be the basis for removal of the affected product from the QPL.

3.4 Material. The material shall be as specified herein. However, when a definite material is not specified, a material shall be used which will enable the capacitors to meet the performance requirements of this specification. Acceptance or approval of any constituent material shall not be construed as a guaranty of the acceptance of the finished product (see 4.7.1).

3.4.1 Impregnant. The impregnant shall be chemically inactive with respect to the capacitor element and the case. The impregnant, either in the state of original application or as a result of having aged, shall have no adverse effect on the performance of the capacitor. For liquid-impregnated capacitors, the same material shall be used for impregnating as is used for filling.

3.4.2 Metals. Metals shall be of a corrosion-resistant type or shall be plated or treated to resist corrosion. Silver plating shall not be used in any external portions of these capacitors.

3.4.2.1 Dissimilar metals. Where dissimilar metals are used in intimate contact with each other, provision shall be made to provide protection against electrolysis and corrosion. The use of dissimilar metals in contact, which may tend toward active electrolytic corrosion (particularly brass, copper, or steel used in contact with aluminum or aluminum alloy), shall not be acceptable. However, metal plating or metal spraying of dissimilar metals to base metals to provide similar or suitable abutting surfaces will be permitted (for example, the spraying of copper on aluminum for soldering operations will be permitted). The use of dissimilar metals separated by insulating material will also be permitted.

3.4.2.2 Solder. Solder for electrical connections shall be in accordance with QQ-S-571.

3.5 Design and construction. Capacitors shall be of the design, construction, and physical dimensions specified (see 3.1 and 4.7.1).

3.5.1 Capacitor element. The capacitor element shall consist of metallized plastic film. The capacitor dielectric may include uncoated dielectric tissues (plastic film).

3.5.1.1 Construction. All capacitors shall have extended electrode construction to minimize inductance.

3.5.2 Case. Each capacitor shall be enclosed in a hermetically-sealed metal or ceramic (magnetic or nonmagnetic, as specified (see 3.1)) case which will prevent leakage of the impregnant, and in addition, will protect the capacitor element from moisture and mechanical damage under all the test conditions specified herein. The end seals shall be glass- or ceramic-to-metal seals.

3.5.2.1 Insulating sleeves. Shrink-fitted insulation shall be used for the sleeves, and shall lap over the ends of the capacitor body.

3.5.3 Axial-wire lead terminals. Axial-wire lead terminals shall be as specified (see 3.1).

3.5.3.1 Solder dip (retinning) leads. Only the manufacturer (or his authorized category B or C distributor) may solder dip/retin the leads of product supplied to this specification provided the solder dip process has been approved by the qualifying activity.

3.5.3.2 Qualifying activity approval. Approval of the solder dip process will be based on one of the following options:

- a. When the original lead finish qualified was hot solder dip lead finish 52 of MIL-STD-1276 (Note: The 200 microinch maximum thickness is not applicable), the manufacturer shall use the same solder dip process for retinning as is used in the original manufacture of the product.
- b. When the lead originally qualified was not hot solder dip lead finish 52 of MIL-STD-1276 as prescribed in a., approval for the process to be used for solder dip shall be based on the following test procedure:
  - (1) Thirty samples of any capacitance value for each style and lead finish are subjected to the manufacturing's solder dip process. Following the solder dip process, the capacitors are subject to the CAP, DF, and IR measurements. No defects are allowed. (Note: If X-ray and hermetic seal testing are required in group A, these tests would also be performed.) No defects are allowed.
  - (2) Ten of the 30 samples are then subjected to the solderability test. No defects are allowed.
  - (3) The remaining 20 samples are subjected to the resistance to solder heat test followed by the seal test. No defects are allowed. (Note: Solder dip of gold plated leads is not allowed.)

3.5.3.3 Solder dip/retinning options. The manufacturer (or authorized category C distributor) may solder dip/retin as follows:

- a. As a corrective action if the lot fails the group A solderability test.
- b. After the group A inspection has been completed, following the solder dip/retinning process, the CAP, DF, and IR measurements shall be performed on 100 percent of the lot. The percent defective allowable (PDA) for the electrical measurements shall be as for the subgroup 1 tests. (Note: If X-ray and hermetic seal are required in the group A, subgroup 1 tests, these tests shall be repeated.) Following these tests, the manufacturer shall submit the lot to the group A solderability test as specified in 4.7.15.

3.6 Burn-in (when specified, see 3.1). When tested as specified in 4.7.2, capacitors shall withstand the exposure to high temperature and overvoltage without visible damage.

3.7 Dielectric absorption (when specified, see 3.1). When measured as specified in 4.7.3, the dielectric absorption shall not exceed the value specified.

3.8 Thermal shock. When tested as specified in 4.7.4, capacitors shall withstand the extremes of high and low temperatures without visible damage.

3.9 Seal. When capacitors are tested as specified in 4.7.5, there shall be no repetitive bubbling, and for liquid-impregnated capacitors, there shall be no evidence of leakage. Capacitors shall then be subjected to dielectric withstanding voltage, insulation resistance, capacitance and dissipation factor as specified in 4.7.6, 4.7.7, 4.7.8, and 4.7.9, respectively.

3.10 Dielectric withstanding voltage. When tested as specified in 4.7.6, capacitors shall be capable of withstanding the potentials specified (see 3.1) without permanent damage, or open- or short-circuiting.

3.11 Insulation resistance (see 4.7.7).

3.11.1 Terminal to terminal. When measured as specified in 4.7.7b.(1), the insulation resistance shall be not less than the values specified (see 3.1).

3.11.2 Terminals to case (when case is not a terminal). When measured as specified in 4.7.7b.(2), the insulation resistance between terminals and case shall be not less than the value specified (see 3.1).

3.12 Capacitance. When measured as specified in 4.7.8, the capacitance shall be within the applicable tolerance specified (see 3.1).

3.13 Dissipation factor. When measured as specified in 4.7.9, the dissipation factor shall not exceed the value specified (see 3.1).

3.14 Equivalent series resistance (ESR) (applicable to styles CRH11, CRH12, CRH13, CRS11, CRS12, and CRS13. When measured as specified in 4.7.10, the ESR (in ohms) shall not exceed the value specified (see 3.1).

3.15 Barometric pressure (reduced). When tested as specified in 4.7.11, capacitors shall withstand the specified potential (see 3.1) without visible damage, external flashover, or open- or short-circuiting.

3.16 Vibration, high frequency. When capacitors are tested as specified in 4.7.12, there shall be no evidence of mechanical damage, no intermittent contacts of 0.5 millisecond (ms) or greater duration, or open- or short-circuiting.

3.17 Salt spray (corrosion). When capacitors are tested as specified in 4.7.13, there shall be no harmful or extensive corrosion, and at least 90 percent of any exposed metal surface of the capacitor shall be protected by the finish. Harmful corrosion shall be construed as being any type of corrosion which in any way interferes with mechanical or electrical performance. In addition, there shall be no unwrapping of, or mechanical damage to the insulating sleeves, when applicable.

3.18 Immersion. When tested as specified in 4.7.14, capacitors shall meet the following requirements:

Dielectric withstanding voltage:

Insulating sleeves - - - - -	Shall be greater than 4,000 volts, dc.
Terminal to terminal - - - - -	Shall be as specified (see 3.1).
Terminals to case (when case is not a terminal) - - - - -	Shall be as specified (see 3.1).

Insulation resistance:

Insulating sleeves - - - - -	Shall be 10,000 megohms, minimum.
Terminal to terminal - - - - -	Shall be not less than the specified percent of the initial requirement (see 3.1).

Terminals to case (when case is not a terminal) - - - - -	Shall be not less than the value specified (see 3.1).
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Capacitance - - - - -	Shall change not more than the specified percent (see 3.1) of the initial measured value.
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Dissipation factor - - - - -	Shall not be more than the specified percent (see 3.1).
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As a result of the test, corrosion of exposed metal surfaces shall not exceed 10 percent. Discoloration and tarnishing alone shall not be cause for rejection. There shall be no unwrapping of, or mechanical damage to the insulating sleeves, when applicable.

**3.19 Solderability.** When capacitors are tested as specified in 4.7.15, the dipped portion of the terminals shall conform to the solid-wire termination criteria of method 208 of MIL-STD-202.

**3.20 Shock (specified pulse).** When capacitors are tested as specified in 4.7.16, there shall be no mechanical damage, no evidence of intermittent contacts of 0.5 ms or greater duration, or open- or short-circuiting.

**3.21 Resistance to soldering heat.** When tested as specified in 4.7.17, capacitors shall meet the following requirements:

Insulation resistance - - - - -	Shall be as specified in 3.11.
Capacitance - - - - -	Shall change not more than the specified percent of the initial measured value (see 3.1).
Dissipation factor - - - - -	Shall be not greater than initial limit.

**3.22 Moisture resistance.** When tested as specified in 4.7.18, capacitors shall meet the following requirements:

<b>Dielectric withstanding voltage:</b>	
Insulating sleeves - - - - -	Shall be greater than 4,000 volts, dc.
Terminal to terminal - - - - -	Shall be as specified (see 3.1).
Terminals to case (when case is not a terminal) - - - - -	Shall be as specified (see 3.1).
<b>Insulation resistance:</b>	
Insulating sleeves - - - - -	Shall be 10,000 megohms, minimum.
Terminal to terminal - - - - -	Shall be not less than the specified percent of the initial requirement (see 3.1).
Terminals to case (when case is not a terminal) - - - - -	Shall be not less than the value specified (see 3.1).
Capacitance - - - - -	Shall change not more than the specified percent (see 3.1) of the initial measured value.
Dissipation factor - - - - -	Shall be not more than the specified percent (see 3.1).

As a result of the test, corrosion of exposed metal surfaces shall not exceed 10 percent. Discoloration and tarnishing alone shall not be cause for rejection. There shall be no unwrapping of, or mechanical damage to the insulating sleeves.

**3.23 Terminal strength.** When capacitors are tested as specified in 4.7.19, there shall be no permanent damage to the terminals or seal.

**3.24 Low-temperature life.** When capacitors are tested as specified in 4.7.20, there shall be no evidence of mechanical damage.

**3.25 Fungus.** The manufacturer shall certify that all external materials are nonnutrient or shall perform the test specified in 4.7.21. When capacitors are tested as specified in 4.7.21, inspection shall disclose no evidence of fungus growth.



3.26 Resistance to solvents. When capacitors are tested as specified in 4.7.22, marking shall remain legible and shall not smear or rub off. In addition, there shall be no visible indication of damage or deterioration of the capacitor body.

3.27 Temperature coefficient. When capacitors are tested as specified in 4.7.23, the capacitance changes at the specified temperatures shall not exceed the applicable limits (see 3.1).

3.28 Life. When tested as specified in 4.7.24, capacitors shall meet the following requirements:

Insulation resistance:	
Terminal to terminal- - - - -	Shall be not less than the specified percent of the initial requirement (see 3.1).
Terminals to case (when case is not a terminal)- - - - -	Shall be not less than the value specified (see 3.1).
Capacitance - - - - -	Shall change not more than the specified percent of the initial measured value (see 3.1).
Dissipation factor- - - - -	Shall be not greater than the limit specified (see 3.1).
Visual inspection - - - - -	There shall be no corrosion, leakage of impregnant, or mechanical damage either during or after the test.

3.29 AC conditioning (when specified, see 3.1). When tested as specified in 4.7.25, capacitors shall withstand the ac voltage exposure without visible damage.

3.30 Flash point of impregnant (when specified, see 3.1). When tested as specified in 4.7.26, the flash point of impregnant shall be not lower than 145°C.

3.31 Marking. Marking of capacitors shall conform to method 1 of MIL-STD-1285, and shall include the Part Number or Identifying Number (PIN), "JAN" marking, date code, lot symbol, manufacturer's source code, capacitance (in  $\mu$ F), capacitance tolerance, and rated voltage (see 4.7.1).

Example of marking:

M83421/01-	- PIN (may be on one line if space permits).
2107M	
.018 $\mu$ F 5% 50 V	- Capacitance, capacitance tolerance, and rated voltage (dc or ac, as applicable).
JAN 8133A 12345	- "JAN" marking, date code, lot symbol, and source code (manufacturer's item serial number may be included if space permits).

The manufacturer shall provide for lot traceability by date code and lot symbol. Manufacturing records shall include these same date codes and lot symbols.

3.31.1 "JAN" and "J" marking. The United States Government has adopted, and is exercising legitimate control over the certification marks "JAN" and "J", respectively, to indicate electrical equipment, namely, resistors, capacitors, electron tubes and the like, acquired by, or manufactured for use by, or for the Government in accordance with standard Government specifications. Accordingly, capacitors acquired to, and meeting all of the criteria specified herein, and in applicable specification sheets shall bear the certification mark "JAN", except the capacitors too small to bear the certification mark "JAN" shall bear the letter "J". Capacitors furnished under contracts or orders which either permit or require deviation from the conditions or requirements specified herein and in applicable specification sheets shall not bear "JAN" or "J". In the event a capacitor sample fails to meet the requirements of this specification and the applicable specification sheets, the manufacturer shall remove the "JAN" or the "J" from the sample tested and also from all capacitors represented by the sample. The United States Government has obtained Certificate of Registration No. 504,860 for the certification mark "JAN".

3.31.2 Marking of established reliability (ER) parts. An ER part manufactured in accordance with MIL-C-83421/1 may be marked and furnished as an (ER) part to MIL-C-39022/9 if produced on the same assembly line or lines, with the following style restrictions:

MIL-C-83421/1 Style	Will Qualify MIL-C-39022/9 style
CRH01 CRH06	CHRO1A, CHRO1B, CHRO1C CHRO1C
CRH02 CRH07	CHRO1D, CHRO1E, CHRO1F CHRO1F
CRH03 CRH08	CHRO1G, CHRO1H, CHRO1J CHRO1J
CRH04 CRH09	CHRO1K, CHRO1L, CHRO1M CHRO1M
CRH05 CRH00	CHRO1N, CHRO1P, CHRO1R CHRO1R

Failure rate level restriction of MIL-STD-690 shall apply.

3.31.3 Supplying to higher failure rate levels. A manufacturer may supply to all higher failure rate levels than to which he is qualified. Parts qualified and marked to lower failure rate levels, with acquiring agency approval, are substitutable for higher failure rate levels, and shall not be remarked unless specified in the contract or acquisition document (see 6.3).

3.31.4 Supplying to looser capacitance tolerance and lower rated voltage. Parts qualified and marked to tighter capacitance tolerance or higher rated voltage, with acquiring agency approval, are substitutable for parts marked to looser capacitance tolerance or lower rated voltage, provided all other values, such as case size, characteristic, and leads are the same. The substitutable parts shall not be remarked unless specified in the contract or acquisition document (see 6.3).

3.32 Workmanship. Capacitors shall be processed in such a manner as to be uniform in quality and shall be free from pits, corrosion, cracks, rough edges, and other defects that will affect life, serviceability, or appearance (see 4.7.1).

#### 4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the manufacturer may use his own or any other facilities suitable for the performance of the inspection requirements specified herein with approval by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items must meet all requirements of section 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of assuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling in quality conformance does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to acceptance of defective material.

4.1.2 Reliability assurance program. A reliability assurance program shall be established and maintained in accordance with MIL-STD-790; "Program implementation" exceptions are as follows:

- a. Under "Description of production processes and controls", the procedure for identification of each production lot shall include only "the manufacturer shall as a minimum be able to identify the time period during which the final production operation was performed on each item of product prior to final test. The date or lot code marked on each part shall be identified to a production lot."
- b. Traceability of materials shall apply to units that will be designated and processed to MIL-C-83421/3, MIL-C-83421/4, and MIL-C-87217.

Evidence of such compliance shall be verified by the qualifying activity of this specification as a prerequisite for qualification and continued qualification.

4.1.3 Statistical process control (SPC). A SPC program shall be established and maintained in accordance with EIA-557. Evidence of such compliance shall be verified by the qualifying activity as a prerequisite for qualification and retention of qualification.

4.2 Classification of inspections. The inspections specified herein are classified as follows:

- a. Qualification inspection (see 4.4).
- b. Verification of qualification (see 4.5).
- c. Quality conformance inspection (see 4.6).

#### 4.3 Inspection conditions and methods.

4.3.1 Conditions. Unless otherwise specified herein, all inspections shall be performed in accordance with the test conditions specified in the "GENERAL REQUIREMENTS" of MIL-STD-202, except relative humidity shall not exceed 75 percent. Unless otherwise specified (see 3.1), accuracy of all test voltage measurements shall be within  $\pm 2.0$  percent of the specified voltage.

#### 4.3.2 Methods.

4.3.2.1 Reference measurements. When requirements are based on comparative measurements made before and after conditioning, the reference measurement shall be considered the last measurement made at  $25^{\circ}\text{C} \pm 3^{\circ}\text{C}$  prior to conditioning. Unless reference measurements have been made within 30 days prior to the beginning of conditioning, they shall be repeated.

4.3.3 Power supply. The power supply used for life testing shall have a regulation of  $\pm 2$  percent or less of the specified test voltage.

4.4 Qualification inspection. Qualification inspection shall be performed at a laboratory acceptable to the Government (see 6.4) on sample units produced with equipment and procedures normally used in production.

4.4.1 Sample size. The number of capacitors to be subjected to qualification inspection shall be as specified in the appendix to this specification.

4.4.2 Inspection routine. Sample units shall be subjected to the qualification inspection specified in table II, in the order shown. All sample units shall be subjected to the inspections of group I (when applicable) and group II. The sample units shall then be divided into five remaining groups as specified in table II, and subjected to the tests for their particular group. Sample units which have been selected to be submitted to the life test shall be divided into two groups; one group shall be subjected to the accelerated condition and the other group to the rated condition. The decision as to whether or not the product is to be included on the qualified products list shall be made at the conclusion of the 2,000-hour life test.

4.4.3 Failures. Failures in excess of those allowed in table II shall be cause for refusal to grant qualification approval.

#### 4.4.4 Failure rate level and quality level verification.

4.4.4.1 Failure rate qualification. Failure rate (FR) qualification shall be in accordance with the general and detailed requirements of MIL-STD-690 and the following details:

- a. Procedure I - Qualification at the initial FR level. Level "M" (1.0 percent) of FRSP-90 shall apply. Sample units shall be subjected to the qualification inspection specified in group VII, table II (see 4.4.2). The life test sample at rated condition shall be continued on test to 10,000 hours as specified in 4.7.24.2.2.
- b. Procedure II - Extension of qualification to lower FR levels. To extend qualification to the "R" (0.01 percent) and "S" (0.001 percent) FR levels, data from two or more styles of similar construction may be combined.
- c. Procedure III - Maintenance of FR level qualification. Maintenance period B of FRSP-10 shall apply. Regardless of the number of production lots produced during this period, the specified number of unit hours shall be accumulated to maintain qualification (see 4.6.1).

4.4.4.2 Quality level verification. The contractor is responsible for establishing a quality system to verify the PPM defect level of lots that are subjected to subgroup 2 tests of the group A inspections. The PPM defect level shall be maintained for each specification sheet. The PPM defect level shall be based on a 5 month moving average. The contractor shall verify and report individual PPM categories (i.e., PPM-2 and PPM-3) and an overall PPM defect level (i.e., PPM-5). In the event that the contractor meets or exceeds 100 PPM for PPM-2 the actions specified in 3.3.2.2.1 shall be taken.

TABLE II. Qualification inspection.

Inspection	Requirement paragraph	Test method paragraph	Number of sample units to be inspected	Number of defectives permitted <u>1/</u>
<u>Group I</u>				
Burn-in (when specified, see 3.1) - - - - -	3.6	4.7.2	89	Not applicable
Dielectric absorption (when specified, see 3.1) - - -	3.7	4.7.3		
<u>Group II 2/</u>				
Visual and mechanical inspection - - - - -	3.1, 3.4, 3.5	4.7.1	89	0
Marking 3/ - - - - -	3.31	4.7.1		
Workmanship (external) - -	3.32	4.7.1		
Thermal shock - - - - -	3.8	4.7.4		
Seal - - - - -	3.9	4.7.5		
Dielectric withstanding voltage - - - - -	3.10	4.7.6		
Insulation resistance - - -	3.11	4.7.7		
Capacitance - - - - -	3.12	4.7.8		
Dissipation factor - - - - -	3.13	4.7.9		
Equivalent series resistance 4/ - - - - -	3.14	4.7.10		
Barometric pressure (reduced) - - - - -	3.15	4.7.11		
<u>Group III</u>				
Vibration, high frequency -	3.16	4.7.12	6	
Salt spray (corrosion) 5/ -	3.17	4.7.13		
Immersion 5/ - - - - -	3.18	4.7.14		
<u>Group IV</u>				
Solderability - - - - -	3.19	4.7.15	6	1
Shock (specified pulse) - -	3.20	4.7.16		
Resistance to soldering heat - - - - -	3.21	4.7.17		
Moisture resistance - - - -	3.22	4.7.18		
<u>Group V</u>				
Terminal strength - - - - -	3.23	4.7.19	6	
Low temperature life - - - -	3.24	4.7.26		

See footnotes at end of table.

TABLE II. Qualification inspection - Continued.

Inspection	Requirement paragraph	Test method paragraph	Number of sample units to be inspected	Number of defectives permitted 1/
<u>Group VI</u>				
Fungus 6/ - - - - -	3.25	4.7.21	4	1
Resistance to solvents - - -	3.26	4.7.22	4	
<u>Group VII</u>				
Temperature coefficient - -	3.27	4.7.23	33	1
Life (accelerated conditions)- - - - -	3.28	4.7.24		
Life (rated condition) - - -	3.28	4.7.24	30	
<u>Group VIII</u>				
AC conditioning - - - - -	3.29	4.7.25	24	1
<u>Group IX</u>				
Flash point of impregnant (when specified, see 3.1)-	3.30	4.7.26	1	0

1/ A sample unit having one or more defects shall be considered as a single defective.

2/ Nondestructive tests.

3/ Marking defects are based on visual inspection only and shall be charged only for illegible, incomplete, or incorrect marking. Any subsequent electrical defects shall not be used as a basis for determining marking defects.

4/ Equivalent series resistance applicable to styles CRH11, CRH12, CRH13, CRS11, CRS12, and CRS13.

5/ One-half of the sample units shall be tested with the insulating sleeves removed.

6/ Certification of fungus resistance may be substituted for testing.

7/ Group VIII for styles CRH11, CRH12, CRH13, CRS11, CRS12, and CRS13 only. Group I and group II samples shall be 113.

4.5 Verification of qualification. Every 6 months, the manufacturer shall compile a summary of the results of quality conformance inspections and, where applicable, extended FR test data, in the form of a verification of qualification report, and forward it to the qualifying activity as the basis of continued qualification approval. In addition, within 30 days of the end of the reporting date, the manufacturer shall immediately notify the qualifying activity whenever the FR data indicates that the manufacturer has failed to maintain his qualified FR level. Continuation shall be based on evidence that, over the 6-month period, the following has been met:

- a. Verification by the qualifying activity that the manufacturer meets the requirements of MIL-STD-790.
- b. The manufacturer has not modified the design of the item.

- c. The specification requirements for the item have not been amended so as to affect the character of the item.
- d. Lot rejection for group A inspection does not exceed 5 percent or one lot, whichever is greater.
- e. The requirements for group B inspection are met.
- f. The records of all FR tests combined substantiate that the "M" (1.0 percent) or "P" (0.1 percent) FR level has been maintained, or that the manufacturer continues to meet the "R" (0.01 percent) and "S" (0.001 percent) FR level for which qualified, although the total component hours of testing does not, as yet, meet the requirements of 4.4.4c.
- g. The contractor shall provide documentation to the qualifying activity pertaining to PPM calculations including numbers of part types tested, individual PPM defect categories (i.e., PPM-2 and PPM-3) and the overall PPM defect rate (PPM-5). This information shall be submitted on a specification sheet basis.

If group B test requirements were not met and the manufacturer has taken corrective action satisfactory to the Government, the forwarding of the verification of qualification report may be delayed until within 30 days after completion of retesting of the group B inspections. In this case, the qualifying activity shall be notified of this condition within the time the original verification of qualification report was due. All reports shall be certified by a responsible company official. The qualifying activity shall be contacted for the report format.

4.5.1 Records. Maintenance of life test and FR level records shall be as specified in MIL-STD-690.

#### 4.6 Quality conformance inspection.

4.6.1 Inspection of product for delivery. Inspection of product for delivery shall consist of group A.

4.6.1.1 Inspection lot. An inspection lot shall consist of all capacitors from the same production line or lines, of the same style, rated voltage, dielectric material, not less than the minimum number of dielectric layers 1/, and offered for inspection during a single work month. Each lot shall be kept separate from every other lot. The sample selected from the lot shall be representative of the capacitance values and case sizes in the lot. All sample units belonging to a lot shall be identified by means of a code symbol (either letters or numbers, at the option of the manufacturer).

4.6.1.2 Subgroup 1 tests. Subgroup 1 tests shall be performed on a production lot basis on 100 percent of the product supplied under this specification. Lots having more than 5 percent total rejects shall not be furnished on contracts. A failure is defined as capacitance value  $\pm 20$  percent of its nominal value, insulation resistance (IR) less than 100 megohms, or dissipation factor (DF) exceeding the limits specified after 10,000-hour life.

<sup>1/</sup> The minimum number of dielectric layers is that number of layers used in the sample units submitted for qualification.

4.6.1.2.1 Manufacturer's production inspection. If the manufacturer performs tests similar to those specified in subgroup 1, table III, as the final step of the production process, group A, subgroup 1 inspection may be waived and the data resulting from the manufacturer's production tests may be used instead. Authority to waive the subgroup 1 inspection shall be granted by the qualifying activity only. The following criteria shall be complied with:

- a. Tests conducted by the manufacturer during production shall be clearly identical to or more stringent than that specified for subgroup 1. Test conditions shall be equal to or more stringent than those specified for subgroup 1 tests.
- b. Manufacturer subjects 100 percent of the product supplied under this specification to the production tests.
- c. The parameters measured and the failure criteria shall be the same or more stringent than those specified herein.
- d. The lot rejection criteria are the same or more stringent than those specified herein.
- e. The manufacturer shall make available all information concerning the test procedures and instrumentation used in the production tests. The manufacturer shall also make available to the Government all records of all detail test data resulting from production tests.
- f. Once approved, the manufacturer shall not change the test procedures or criteria without prior notification and concurrence by the qualifying activity.

TABLE III. Group A inspection.

Inspection	Requirement paragraph	Test method paragraph	Sample	Lot criteria
<u>Subgroup 1</u>				
Burn-in - - - - -	3.6	4.7.2	} 100% inspection	
Thermal shock - - - - -	3.8	4.7.4		
Seal - - - - -	3.9	4.7.5		
Dielectric withstanding voltage - - - - -	3.10	4.7.6		
Insulation resistance (at 25 C) - - - - -	3.11	4.7.7		
Capacitance - - - - -	3.12	4.7.8		
Dissipation factor - - -	3.13	4.7.9		
Equivalent series resistance $\frac{1}{\text{---}}$ - - - -	3.14	4.7.10		

See footnote at end of table.



TABLE III. Group A inspection - Continued.

Inspection	Requirement paragraph	Test method paragraph	Sample	Lot criteria
Subgroup 2 (PPM)				
Insulation resistance at 25°C (PPM-2) - - - -	3.11	4.7.7	See table IV	Reject one defect
Capacitance (PPM-2) - - -	3.12	4.7.8		
Dissipation factor (PPM-2)	3.13	4.7.9		
Equivalent series resistance (PPM-2) 1/	3.14	4.7.10		
Mechanical examination (PPM-3) - - - - -	3.4	4.7.1	13	0 failures
Subgroup 3				
Visual inspection			13	0 failures
Physical dimensions - -	3.1	4.7.1		
External Marking 2/ - - - - -	3.4, 3.5 3.31	4.7.1 4.7.1		
Workmanship - - - - -	3.32	4.7.1		
Subgroup 4				
Solderability - - - - -	3.19	4.7.15	13	0 failures

1/ For styles CRH11, CRH12, CRH13, CRS11, CRS12, CRS13 only.

2/ Marking defects are based on visual inspection and shall be charged only for illegible, incomplete, or incorrect marking. Any subsequent electrical defects shall not be used as a basis for determining marking defects.

TABLE IV. Sampling plans for PPM categories.

Lot size	Sample size
1 - 125	100 percent
126 - 3,200	125
3,201 - 10,000	200
10,001 - 35,000	315
35,001 - 150,000	500
150,001 - 500,000	800
500,001 - up	1,250

#### 4.6.1.2.2 Subgroup 2 tests (PPM categories).

4.6.1.2.2.1 **Sampling plans.** Subgroup 2 tests shall be performed on an inspection lot basis. Samples subjected to subgroup 2 shall be selected in accordance with table IV, based on the size of the inspection lot. In the event of one or more failures, the lot shall be rejected. Equipment and operators used to perform the subgroup 2 tests shall not be the same as those used in the subgroup 1 100 percent tests.

4.6.1.2.2.2 **Rejected lots.** The rejected lot shall be segregated from new lots and those lots that have passed inspection. The rejected lot shall be 100 percent inspected for those quality characteristics found defective in the sample and any defectives found removed from the lot. A new sample of parts shall then be randomly selected in accordance with table IV. If one or more defects are found in this second sample, the lot shall be rejected and shall not be supplied to this specification.

4.6.1.2.2.3 PPM calculations. PPM calculation shall be based on the results of the first sample check as prescribed in 4.6.1.2.2.1. Calculations and data exclusion shall be in accordance with EIA-554. (Note: PPM calculations shall not use data on the second sample submission.)

4.6.1.2.3 Subgroup 3 tests. Subgroup 3 tests shall be performed on an inspection lot basis. Statistical sampling inspection shall be performed on an inspection lot basis. A sample of 13 parts shall then be randomly selected, if one or more defects are found, the lot shall be rescreened and defects removed. A new sample of 13 parts shall then randomly be selected. If one or more defects are found in this second sample, the lot shall be rejected and shall not be supplied to this specification.

4.6.1.2.4 Subgroup 4 tests (solderability).

4.6.1.2.4.1 Inspection lot. An inspection lot for the purpose of subgroup 4 (solderability) testing shall consist of all lots manufactured with the same diameter lead wire and offered for inspection within the same work week. Each manufacturing lot shall be kept separate from every other lot. All samples belonging to a manufacturing lot shall be identified to that lot. Means of identification is at the option of the manufacturer.

4.6.1.2.4.2 Sampling plan. A minimum of 13 pieces shall be selected randomly from each inspection lot; however, each manufacturing lot shall be represented in the sample. If the inspection lot consists of more than 13 manufacturing lots, then a minimum of one sample shall be selected from each manufacturing lot. If there are one or more failures, the inspection lot shall be considered to have failed.

4.6.1.2.4.3 Rejected lots. In the event of one or more defects, the inspection lot is rejected. The manufacturer may use one of the following options to rework the lot:

- a. Each production lot that was used to form the failed inspection lot shall be individually submitted to the solderability test as required in 4.6.1.2.4.2. Production lots that pass the solderability test are available for shipment. Production lots failing the solderability test can be reworked only if submitted to the solder dip procedure in b.
- b. The manufacturer submits the failed lot to a 100 percent solder dip using an approved solder dip process in accordance with 3.5.3.1. Following the solder dip, the electrical measurements required in group A, subgroup 1 tests shall be repeated on 100 percent of the lot. The PDA for the electrical measurements shall be as for the subgroup 1 tests. (Note: If x ray and hermetic seal are required in the group A, subgroup 1 tests, these tests shall be repeated.) Thirteen additional samples shall be then selected and subjected to the solderability test with zero defects allowed. If the lot fails this solderability test, the lot shall be considered rejected and shall not be furnished against the requirements of this specification.

4.6.1.2.4.4 Disposition of samples. The solderability test is considered a destructive test, and samples submitted to the solderability test shall not be supplied on the contract.

4.6.2 Periodic inspection. Periodic inspection shall consist of group B inspection. Except where the results of these inspections show noncompliance with the applicable requirements (see 4.6.2.1.3), delivery of products which have passed group A shall not be delayed pending the results of periodic inspection.

4.6.2.1 Group B inspection. Group B inspection shall consist of the tests specified in table V, in the order shown. Test data obtained therefrom on the periodicity specified in 4.6.2.1.1 shall be reviewed as part of the complete reevaluation of qualification. Group B inspection shall be made on sample units selected from inspection lots which have passed group A inspection.

4.6.2.1.1 Sampling plan. Sample units shall be subjected to the tests specified in table V, in the order shown. Except for subgroup 2, the maximum and minimum case sizes manufactured shall be represented in the sample in at least the approximate ratio of production. Allowable failures shall be as specified in table V. Sampling shall be as follows:

- a. Subgroup 1: A minimum of 10 sample units per inspection lot shall be inspected.
- b. Subgroup 2: Sample units of the same style shall be inspected (see 3.1). Testing need only be done in January and July (30 V dc units); February and August (50 V dc units); March and September (100 V dc units); April and October (200 V dc units); May and November (400 V dc units); and June and December (300 V dc and 600 V dc units).
- c. Subgroup 3: Every 6 months, 18 sample units from production shall be divided and inspected as shown in table V.

TABLE V. Group B inspection.

Inspection	Requirement paragraph	Test method paragraph	Number of sample units to be inspected	Number of defectives permitted
Subgroup 1				
Barometric pressure (reduced) - - - - -	3.15	4.7.11	See 4.6.2.1.1a.	1/
Insulation resistance (at applicable maximum rated temperature - - - - -	3.11	4.7.7		
Temperature coefficient - - - - -	3.27	4.7.23		
Life- - - - -	3.28	4.7.24.2.1		
Subgroup 2				
AC conditioning (when specified, see 3.1) - - - - -	3.29	4.7.25	See 4.6.2.1.1b.	3/
Equivalent series resistance 2/ - - - - -	3.14	4.7.10		
Dissipation factor - - - - -	3.13	4.7.9		
Insulation resistance - - - - -	3.11	4.7.7		
Subgroup 3				
Vibration - - - - -	3.16	4.7.12	6	1
Salt spray (corrosion) 4/ - - - - -	3.17	4.7.13		
Immersion 4/- - - - -	3.18	4.7.14		
Shock (specified pulse) - - - - -	3.20	4.7.16	6	
Resistance to soldering - heat- - - - -	3.21	4.7.17		
Moisture resistance - - - - -	3.22	4.7.18		
Dielectric absorption (when specified, see 3.1)- - - - -	3.7	4.7.3	6	
Terminal strength - - - - -	3.23	4.7.19		
Resistance to solvents - - - - -	3.26	4.7.22		

See footnotes on next page.

TABLE V. Group B inspection - Continued.

- 1/ See MIL-STD-690 for number of defectives permitted.
- 2/ For styles CRH11, CRH12, CRH13, CRS11, CRS12, and CRS13 only.
- 3/ For reference only; data will be submitted to qualifying activity.
- 4/ One-half of the sample units shall be tested with the insulating sleeve removed.

4.6.2.1.2 Disposition of sample units. Sample units which have been subjected to group B inspection shall not be delivered on the contract.

4.6.2.1.3 Noncompliance. If a sample unit fails to pass group B inspection, the manufacturer shall take corrective action on the materials or processes, or both, as warranted, and on all units of product which can be corrected and which were manufactured under essentially the same conditions, with essentially the same materials, processes, and so forth, and which are considered subject to the same failure. Acceptance of the product shall be discontinued until corrective action, acceptable to the Government, has been taken. After the corrective action has been taken, group B inspection shall be repeated on additional sample units (all inspection, or the inspection which the original sample failed, at the option of the Government). Group A inspection may be reinstituted; however, final acceptance shall be withheld until the group B reinspection has shown that corrective action was successful. In the event of failure after reinspection, information concerning the failure and corrective action taken shall be furnished to the cognizant inspection activity and the qualifying activity.

4.6.3 Inspection of packaging. The sampling and inspection of the preservation, packing, and container marking shall be in accordance with the requirements of MIL-C-39028.

#### 4.7 Methods of inspection and test.

4.7.1 Visual and mechanical inspection. Capacitors shall be inspected to verify that the materials, design, construction, physical dimensions, marking, and workmanship are in accordance with the applicable requirements (see 3.1, 3.4, 3.5, 3.31, and 3.32). A 5X to 7X magnification limit shall apply.

4.7.2 Burn-in (see 3.1 and 3.6). Capacitors shall be tested under accelerated voltage conditions as specified in 4.7.22, with the following exceptions:

- a. AC burn-in, 140 percent of rated rms voltage 400 Hz shall be applied on voltages of < 300 volts; 120 percent of rated rms voltage at 400 Hz shall be applied on voltages  $\geq$  350 volts for 16 hours, minimum.
- b. DC burn-in shall be exposed to a temperature of +125°C with 140 percent of dc rated voltage for 16 hours, minimum.

4 7.3 Dielectric absorption (when specified, see 3.1 and 3.7). The capacitor shall be charged at dc rated voltage or 100 volts dc (whichever is less) for a minimum period of 5 minutes. The initial surge current shall not exceed 50 milliamperes. At the end of this period, the capacitor shall be disconnected from the power source and discharged through a 5 ohm  $\pm 1$  percent resistor for 5  $\pm 0.5$  seconds. The discharge resistor shall be disconnected from the capacitor at the end of the 5 second discharge period; and after 1 minute, the voltage remaining on the capacitor (recovery voltage) shall be measured with an electrometer, or other suitable device having an input resistance of 10,000 megohms, or greater. The dielectric absorption shall be computed from the following formula:

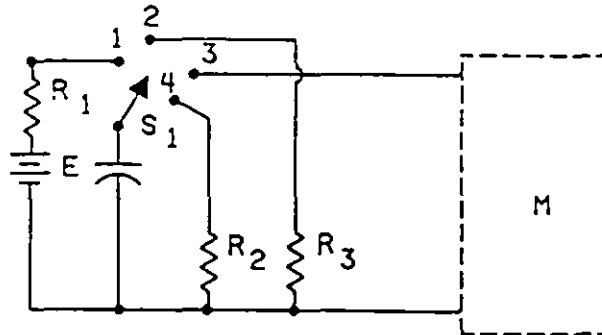
$$d = \frac{V_1}{V_2} \times 100$$

Where:

$d$  = Dielectric absorption (percent).

$V_1$  = Maximum recovery voltage.

$V_2$  = Charging voltage.



$E$  = DC rated voltage or 100 volts dc, whichever is less ( $\pm 2$  percent).

$R_1$  and  $R_2$  = 1000 ohms  $\pm 20$  percent (this value not critical).

$R_3$  = 5 ohms  $\pm 1$  percent.

$M$  = 1230A GR electrometer or equivalent with 10,000 megohms, minimum, input resistance.

FIGURE 1. Typical dielectric absorption test schematic.

4.7.4 Thermal shock (see 3.8). Capacitors shall be tested in accordance with method 107 of MIL-STD-202. The following details and exception shall apply:

- a. Test condition letter B.
- b. Measurements before and after cycling: Not applicable.
- c. Number of cycles: 10 or 5, as specified (see 3.1).

4.7.5 Seal (see 3.9). Capacitors shall be tested in accordance with method 112 of MIL-STD-202. The following details shall apply:

- a. Test condition letters: As specified (see 3.1).
- b. Measurements after test: Not applicable.

4.7.5.1 Alternate test for liquid-impregnated capacitors only. Capacitors shall be placed with the terminals facing sideways (not upward) on a clean sheet of absorbent paper and exposed to a case temperature within  $+3^{\circ}\text{C}$ ,  $-0^{\circ}\text{C}$  of the applicable maximum rated temperature (see 3.1) for a period of 4 hours, minimum.

After the test, capacitors (and absorbent paper, if used) shall be visually inspected for evidence of leakage of impregnant.

4.7.6 Dielectric withstanding voltage (see 3.10). Capacitors shall be tested in accordance with method 301 of MIL-STD-202. The following details and exception shall apply:

- a. Magnitude and nature of test voltage: As specified (see 3.1).
- b. Points of application of test voltage: Between terminals.
- c. Power supply voltage regulation:  $\pm 2$  percent or better.
- d. Current resistor: Sufficient to limit charging current 1.0 ampere, maximum.

4.7.7 Insulation resistance (see 3.11). Capacitors shall be tested in accordance with method 302 of MIL-STD-202. The following details shall apply:

- a. Test potential: Rated voltage, unless otherwise specified (see 3.1).
- b. Points of measurement:
  - (1) Terminal to terminal: Between terminals at the applicable specified temperatures (see 3.1), and at  $25^{\circ}\text{C} \pm 3^{\circ}\text{C}$ .
  - (2) Terminals to case (when case is not a terminal): Between each terminal and the case at  $25^{\circ}\text{C} \pm 3^{\circ}\text{C}$ .

4.7.8 Capacitance (see 3.12). Capacitors shall be tested in accordance with method 305 of MIL-STD-202. Unless otherwise specified (see 3.1), the following details shall apply:

- a. Test-frequency: 1,000  $\pm 100$  Hz.
- b. Limit of accuracy: Within  $\pm 0.05$  percent.

4.7.9 Dissipation factor (see 3.13). Unless otherwise specified (see 3.1), the dissipation factor shall be measured at 1,000  $\pm$ 100 Hz (for capacitors having a nominal capacitance of 1  $\mu$ F or less) or 100  $\pm$ 10 Hz (for capacitors having a nominal capacitance greater than 1  $\mu$ F).

4.7.10 Equivalent series resistance (ESR) applicable to styles CRH11, CRH12, CRH13, CRS11, CRS12, and CRS13 (see 3.14). ESR shall be determined by a suitable measuring device. Instrument measurement accuracy shall be within  $\pm$ 2 percent. AC measurements shall be made at a frequency of 100 kHz  $\pm$ 10 percent. ESR is to be measured within .250 to .500 inch of case.

4.7.11 Barometric pressure (reduced) (see 3.15). Capacitors shall be tested in accordance with method 105 of MIL-STD-202. The following details shall apply:

- a. Method of mounting: By normal mounting means.
- b. Test condition letter D (100,000 feet), unless otherwise specified (see 3.1).
- c. Tests during subjection to reduced pressure: The specified potential (see 3.1) shall be applied for at least 1 minute between each terminal and the case when the terminal is not connected to the case, or between the insulated terminal and the case when the case is a terminal. However, at no time shall the potential exceed those limits specified (by altitude and case diameter) on figure 2. A suitable means shall be used to detect momentary or permanent breakdown.

After the test, capacitors shall be visually inspected for evidence of damage.

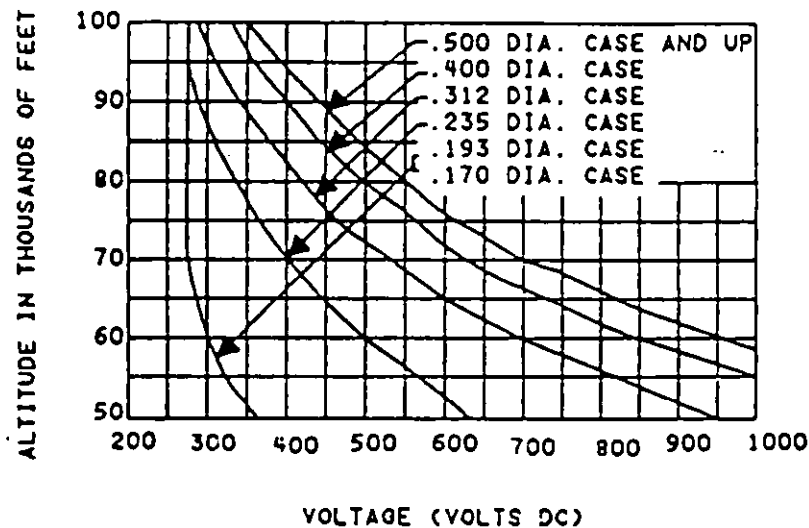


FIGURE 2. Breakdown voltage vs. altitude.

4.7.12 Vibration, high frequency (see 3.16). Capacitors shall be tested in accordance with method 204 of MIL-STD-202. The following details and exceptions shall apply:

- a. Mounting of specimens: Rigidly mounted by the body to the vibration-test apparatus; terminals shall be secured  $0.500 \pm 0.125$  inch from the case.
- b. Electrical-load conditions: During the test, a dc potential equal to 50 percent of the rated voltage (see 3.1) shall be applied between the terminals of the capacitor.
- c. Test condition letter E (50 g's), unless otherwise specified (see 3.1).
- d. Duration and direction of motion: 4 hours in each of two mutually perpendicular directions (total of 8 hours), one parallel and the other perpendicular to the cylindrical axis.
- e. Measurements: During the last cycle in each direction, a signal of  $1 \pm 0.2$  kHz at a level of  $1 \pm 0.05$  volt shall be placed across the capacitor and measured with a suitable ac recording device (a permanent record is not necessary for this test) to determine open- or short-circuits, or intermittent contacts. The accuracy of the detecting equipment shall be sufficient to detect any interruption of 0.5 ms or greater duration.
- f. Measurements after vibration: Not applicable.

After the test, capacitors shall be visually inspected for evidence of mechanical damage or open- or short-circuiting.

4.7.13 Salt spray (corrosion) (see 3.17). Capacitors shall be tested in accordance with method 101 of MIL-STD-202. The following details shall apply:

- a. Test condition letter B (48 hours).
- b. Measurements after exposure: Not applicable.

After the test, capacitors shall be visually inspected for evidence of harmful corrosion and unwrapping of, or mechanical damage to the insulating sleeves, when applicable.

4.7.14 Immersion (see 3.18). Capacitors shall be tested in accordance with method 104 of MIL-STD-202. The following details and exception shall apply:

- a. Test condition letter C, with the following exceptions:
  - (1) Both hot and cold baths shall be a saturated solution of sodium chloride and water.
  - (2) For quality conformance inspection only, two immersion cycles and .30 minute exposure shall be required.
- b. Inspections after final cycle: Capacitors shall be inspected for evidence of extensive corrosion, and unwrapping of, or mechanical damage to the insulating sleeves, when applicable.



- c. Measurements after final cycle: Dielectric withstanding voltage and insulation resistance shall be measured only on the insulating sleeves of case sizes .400 diameter x 1.063 long and larger at  $25^{\circ}\text{C} \pm 3^{\circ}\text{C}$  as specified in 4.7.6 and 4.7.7, respectively, except the measurements shall be made between two wire windings placed around the sleeve of the capacitor 0.500 inch apart; each winding shall consist of three close turns of 0.040 inch (18 AWG) bare copper wire. The insulating sleeves of all sizes shall be removed, and the dielectric withstanding voltage, insulation resistance, capacitance, and dissipation factor shall then be measured at  $25^{\circ}\text{C} \pm 3^{\circ}\text{C}$  as specified in 4.7.6 to 4.7.9, inclusive.

4.7.15 Solderability (see 3.19). Capacitors shall be tested in accordance with method 208 of MIL-STD-202. The following details shall apply:

- a. Number of terminations of each capacitor to be tested: 2.
- b. Depth of immersion in flux and solder: Both terminals shall be immersed to within 0.125 inch of the capacitor body or eyelet closure.
- c. No physical damage after test.

4.7.16 Shock (specified pulse) (see 3.20). Capacitors shall be tested in accordance with method 213 of MIL-STD-202. The following details shall apply:

- a. Special mounting means: Rigidly mounted by the body.
- b. Test condition letter I.
- c. Electrical loading during shock: During the test, a potential of 50 percent of rated voltage shall be applied between the terminals of the capacitor.
- d. Measurements during and after shock: During the test, a cathode-ray oscilloscope (or other comparable means) shall be used as an indicating device in determining any electrical failures and intermittent contacts of 0.5 ms or greater duration, or open- or permanent short-circuiting.

After the test, capacitors shall be visually inspected for evidence of breakdown, arcing, fractures, and other visible mechanical damage.

4.7.17 Resistance to soldering heat (see 3.21). Capacitors shall be tested in accordance with method 210 of MIL-STD-202. The following details shall apply:

- a. Depth of immersion in molten solder: To a minimum of 0.250 inch from the capacitor body.
- b. Test condition letter G ( $260^{\circ}\text{C} \pm 5^{\circ}\text{C}$  for  $10 \pm 1$  seconds).
- c. Cooling time prior to final measurement: Sufficient time to stabilize at room temperature.
- d. Measurements after test: Insulation resistance, capacitance, and dissipation factor shall be measured at  $25^{\circ}\text{C} \pm 3^{\circ}\text{C}$  as specified in 4.7.7, 4.7.8, and 4.7.9, respectively.

4.7.18 Moisture resistance (see 3.22). Capacitors shall be tested in accordance with method 106 of MIL-STD-202. The following details and exceptions shall apply:

- a. Mounting: As specified in 4.7.11a. Capacitors which are normally supported by their wire leads shall be mounted to rigidly supported terminals so spaced that the length of each lead from the capacitor body shall be approximately 0.625 inch. Tubular capacitors greater than 0.562 inch nominal diameter and 1.562 inches in length shall have a supplementary mounting means, and the leads shall be supported at the ends during vibration.
- b. Subcycle: A total of five subcycles shall be performed. The vibration required in step 7 shall be in any direction.
- c. Loading (polarization): During steps 1 to 6 inclusive, a dc potential of 100 volts or rated voltage (see 3.1), whichever is less, shall be applied across the terminals of 50 percent of the capacitors. No potential shall be applied to the remaining 50 percent of the capacitors.
- d. Final measurements: After the final cycle, capacitors shall be conditioned at  $25^{\circ}\text{C} \pm 10^{\circ}\text{C}$ ,  $-5^{\circ}\text{C}$  at a relative humidity of less than 80 percent, and a barometric pressure between 28 and 32 inches of mercury. After a maximum of 24 hours, capacitors shall be inspected for evidence of extensive corrosion, and unwrapping of, or mechanical damage to the insulating sleeves. Dielectric withstanding voltage and insulation resistance shall be measured only on the insulating sleeves of case sizes .400 diameter x 1.063 long and larger at  $25^{\circ}\text{C} \pm 3^{\circ}\text{C}$  as specified in 4.7.6 and 4.7.7, respectively, except the measurements shall be made between two wire windings placed around the sleeve of the capacitor 0.500 inch apart; each winding shall consist of three close turns of 0.040 inch (18 AWG) bare copper wire. The insulating sleeves of all case sizes shall be removed, and the dielectric withstanding voltage, insulation resistance, capacitance, and dissipation factor shall then be measured at  $25^{\circ}\text{C} \pm 3^{\circ}\text{C}$  as specified in 4.7.6 to 4.7.9, inclusive.

After the test, capacitors shall be visually inspected for evidence of extensive corrosion, and unwrapping of, or mechanical damage to the insulating sleeves.

4.7.19 Terminal strength (see 3.23). Capacitors shall be tested in accordance with method 211 of MIL-STD-202. The following details and exceptions shall apply:

- a. Test condition letters A (pull test) and C (bend test).
- b. Test condition A:
  - (1) Method of holding: Capacitors shall be clamped by one terminal, and pull test load applied to the other terminal.
  - (2) Applied force: 5 pounds.

4.7.20 Low temperature life (see 3.24). Unless otherwise specified (see 3.1), capacitors shall be placed in a chamber maintained at  $-65^{\circ}\text{C} \pm 0^{\circ}\text{C}$ ,  $-3^{\circ}\text{C}$  and a potential equal to dc rated voltage shall be applied at this temperature for 48  $\pm$  4 hours. After the test, capacitors shall be visually inspected for evidence of breakdown arcing, open and short-circuiting, and other visible mechanical damage.

4.7.21 Fungus (see 3.25). Capacitors shall be tested in accordance with method 508 of MIL-STD-810.

4.7.22 Resistance to solvents (see 3.26). Capacitors shall be tested in accordance with method 215 of MIL-STD-202. The following details shall apply:

- a. Portion of specimen to be brushed: That portion on which marking is present.
- b. Number of specimens to be tested: As specified, see tables II and V.
- c. Permissible extent of damage: As specified in 3.26.

Following each immersion, capacitors shall be brushed with a common hard-bristle toothbrush for 10 strokes. Brushing force shall be 1 pound.

4.7.23 Temperature coefficient (see 3.27). Capacitance shall be measured as specified in 4.7.8 at the temperatures specified (see 3.1). The measurement at each temperature shall be recorded when two successive readings taken at 5 minute intervals indicate no change in capacitance.

4.7.24 Life (see 3.28).

4.7.24.1 For qualification inspection. Capacitors shall be tested in accordance with method 108 of MIL-STD-202. The following details and exceptions shall apply:

- a. Distance of temperature measurements from specimens in inches: Not applicable.
- b. Test temperature and tolerance: Applicable maximum rated temperature, +4°C, -0°C (see 3.1). Radiation shall not be used as a means of heating the chamber.
- c. Operating conditions: Those capacitors being tested at the accelerated condition shall be subjected to the specified percent of rated voltage (see 3.1); those capacitors being tested at the rated condition shall be subjected to rated voltage. The power supply shall be capable of providing the required voltage to all capacitors under test. Suitable metering devices shall be provided to verify that the correct voltage is being applied to all capacitors.
- d. Test condition letter F (2,000 +72, -0 hours).
- e. Measurements during test: Not applicable.
- f. Measurements after life test: Capacitors shall be returned to the inspection conditions specified in 4.3. The insulating sleeves shall be removed and the insulation resistance, capacitance, and dissipation factor shall be measured as specified in 4.7.7, 4.7.8, and 4.7.9, respectively.

After the test, capacitors shall be visually inspected for evidence of corrosion, leakage of impregnant, and mechanical damage.

4.7.24.2 Quality conformance inspection.

4.7.24.2.1 Accelerated condition. Capacitors shall be tested as specified in 4.7.24.1, except at the accelerated condition only, measurements shall be accomplished after 1,000 +48, -0 and 2,000 +72, -0 hours.

4.7.24.2.2 Rated condition. Upon completion of the 2,000-hour test and related inspections, those capacitors which were tested under the rated condition shall be tested for an additional 8,000 hours; measurements shall be accomplished after 2,000  $\pm 72$ , -0 and every 2,000  $\pm 72$ , -0 hours thereafter, until 10,000  $\pm 96$ , -0 hours have elapsed.

4.7.25 AC conditioning (when specified, see 3.1 and 3.29). Capacitors shall be exposed to the voltages and frequencies specified at 100 C for 240  $\pm 48$ , -0 hours.

4.7.26 Flash point of impregnant (see 3.30). The flash point of impregnant shall be measured as specified in ASTM-D92, except that fire point and precision do not apply. The word "impregnant" shall be substituted for the word "oil" throughout the test method.

## 5. PACKAGING

5.1 Packaging requirements. The requirements for packaging shall be in accordance with MIL-C-39028.

## 6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Solder dip (retinning). If retinning (hot solder dip) of the leads is required, see 3.5.3.1.

6.2 Intended use. Capacitors covered by this specification are primarily intended for use in power supply filter circuits, by-pass applications, and other applications where the ac component of voltage is known or a significant factor. Styles covered by this specification may be used for applications requiring a tight capacitance tolerance, excellent capacitance stability, very high-insulation resistance, and low-loss factors where the ac component of voltage is large with respect to the applied dc voltage. These capacitors can exhibit momentary breakdowns. If sufficient energy is available from the circuit and stored in the capacitor, clearing will occur. Minimum stored energy in the range 100 to 500 microjoules is recommended to insure clearing. Applications for these capacitors shall be limited to circuits that will provide sufficient energy to insure clearing and are insensitive to momentary breakdown/clearing actions.

6.3 Acquisition requirements. Acquisition documents must specify the following:

- a. Title, number, and date of the specification.
- b. Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1).
- c. Title, number, and date of the applicable specification sheet, and the complete part number and lead material if other than that specified (see 3.1).

6.4 Qualification. With respect to products requiring qualification, awards will be made for products which are at the time set for opening of bids, qualified for inclusion in the applicable qualified products list whether or not such products have actually been so listed by that date. The attention of the contractors is called to this requirement, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or purchase orders for the products covered by this specification. The activity responsible for the qualified products list is the Department of the Air Force, however, information pertaining to qualification of products may be obtained from the Defense Electronics Supply Center (DESC-EQP), 1507 Wilmington Pike, Dayton, Ohio 45444-5287, agent for administration of the Qualified Products List. Application for qualification tests shall be made in accordance with "Provisions Governing Qualification" (see 6.4.1).

6.4.1 Copies of SD-6, "Provisions Governing Qualification" may be obtained upon application to the Standardization Documents Order Desk, Building 40, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

#### 6.5 Subject term (key word) listing.

Capacitance

#### 6.6 PIN examples.

M83421/01-1	123	M	
			Single letter designating FR levels (M, P, R, and S)
			Nonsignificant dash number
			Single digit designating style
			Slash sheet number
			Military specification number

M83421/03-1	123	
		Nonsignificant dash number
		Single digit designating style
		Slash sheet number
		Military specification number

6.7 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

## APPENDIX

## PROCEDURE FOR QUALIFICATION INSPECTION

## 10. SCOPE

10.1 Scope. This appendix details the procedure for submission of samples, with related data, for qualification inspection of capacitors covered by this specification. The procedure for extending qualification of the required sample to other capacitors covered by this specification is also outlined herein. This appendix is a mandatory part of the specification. The information contained herein is intended for compliance.

10.2 Qualification categories. Qualification shall be categorized as follows:

Category A: Qualification shall be in accordance with the requirements of this specification.

20. APPLICABLE DOCUMENTS. This section is not applicable to this appendix.

## 30. SUBMISSION

30.1 Sample. For qualification to "M" level (see 3.1) as in accordance with table II.

30.1.1 Single type submission. A sample consisting of 89<sup>2/</sup> sample units of the same style, dielectric material, rated voltage, capacitance value, and capacitance tolerance for which qualification is sought shall be submitted.

30.1.2 Single style submission. A sample consisting of 45<sup>3/</sup> sample units of the highest capacitance value in the smallest case size and 45<sup>3/</sup> sample units of the highest capacitance value in the largest case size, within a single style, shall be submitted. The dielectric material and FR level of the sample units shall be the same.

30.1.3 Complete qualification group submission. The types and number of samples which shall be submitted for qualification approval are those shown in table VI and shall be grouped in accordance with that table.

30.1.4 Impregnant. Two-hundred cubic centimeters of each impregnant used in the specimens for which approval is sought shall be submitted. On subsequent submissions, an impregnant which has successfully withstood the flash point of impregnant test (see 4.7.26) need not be submitted.

30.2 Test data. When specifically requested, each submission shall be accompanied by test data covering the nondestructive tests listed in table II which have been performed on the specimens. The performance of the destructive tests by the manufacturer on a duplicate set of specimens is encouraged, although not required. All test data shall be submitted in duplicate.

<sup>2/</sup> For styles CRH11, CRH12 and CRH13, 113 sample units.

<sup>3/</sup> For styles CRH11, CRH12 and CRH13, 57 sample units.

## APPENDIX

30.3 Description of items. The manufacturer shall submit a detailed statement of the materials and constructional features of the capacitors being submitted for test, including information on whether they are liquid-impregnated; the type and quantity of the impregnant; the type, thickness, and number of layers of the capacitor tissue; and material, thickness, and applied finish of the case.

## 40. EXTENT OF QUALIFICATION

40.1 Single type submission. Qualification of a capacitance type will be restricted to the dielectric material, rated voltage, and capacitance value submitted. Capacitance-tolerance qualification will be restricted to the capacitance tolerances equal to and wider than the tolerance submitted. Extent of FR level qualification shall be as specified in 40.4.

40.2 Single style submission. Qualification of the capacitance types submitted will be a basis for qualification for all capacitance values and case sizes in the style. If the tightest capacitance tolerance is included, complete capacitance range qualification may be granted. Extent of FR level qualification shall be as specified in 40.4

TABLE VI. Samples for complete qualification submission.

Style	Qualification group	Types to be submitted	Quantity for complete qualification groups
CRH01	30 V	Maximum capacitance value	45
CRH02	50 V	Maximum capacitance value	45
CRH03	100 V	Maximum capacitance value	45
CRH04	200 V	Maximum capacitance value	45
CRH05	400 V	Maximum capacitance value	45
CRH11	100 V	Maximum capacitance value	45
CRH12	200 V	Maximum capacitance value	45
CRH13	400 V	Maximum capacitance value	45
CRH21	50 V	Maximum capacitance value	45
CRH22	100 V	Maximum capacitance value	45
CRH23	200 V	Maximum capacitance value	45
CRH24	300 V	Maximum capacitance value	45
CRH25	400 V	Maximum capacitance value	45

## APPENDIX

40.3 Complete qualification group submission. Qualification of the complete qualification group submission will be the basis for qualification for all styles within a specification sheet, dielectric materials, rated voltages, capacitance values, and capacitance tolerances; if the tightest capacitance tolerance is included in at least one style, complete capacitance range, qualification may be granted. Extent of FR level qualification shall be as specified in 40.4.

40.4 FR level qualification. The extent of qualification between FR levels shall be as specified in table VII.

TABLE VII. Extent of FR level qualification.

Qualification for FR level	Will qualify FR level(s)
S	S, R, P, M
R	R, P, M
P	P, M
M	M

## 50. QUALIFICATION APPROVAL FOR LOWER FR LEVELS

50.1 FR qualification. Extension of qualification to lower FR levels shall be in accordance with 4.4.4 of this specification.



CONCLUDING MATERIAL

Custodians:

Army - ER  
Navy - EC  
Air Force - 85  
NASA - NA

Preparing activity:

Air Force - 85

Agent:

DLA - ES

Review activities:

Army - AR  
DLA - ES

(Project 5910-1685)

User activities:

Navy - AS, CG, MC, OS, SH  
Air Force - 19

# STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

## INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7.
3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

<b>I RECOMMEND A CHANGE:</b>		1. DOCUMENT NUMBER MIL-C-834218		2. DOCUMENT DATE (YYMMDD) 31 January 1991	
3. DOCUMENT TITLE CAPACITORS, FIXED, METALLIZED, PLASTIC FILM DIELECTRIC, (DC, AC, OR DC AND AC), HERMETICALLY SEALED IN METAL OR CERAMIC CASES, ESTABLISHED RELIABILITY, GENERAL					
4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.) SPECIFICATION FOR					
5. REASON FOR RECOMMENDATION					
6. SUBMITTER					
a. NAME (Last, First, Middle Initial)			b. ORGANIZATION		
c. ADDRESS (Include Zip Code)			d. TELEPHONE (Include Area Code)		7. DATE SUBMITTED (YYMMDD)
			(1) Commercial		
			(2) AUTOVON (If applicable)		
B. PREPARING ACTIVITY					
a. NAME 2750LOG/ES			b. TELEPHONE (Include Area Code)		
			(1) Commercial (2) AUTOVON		
			513- 296-5517 986-5517		
c. ADDRESS (Include Zip Code) GENTILE AFS OH 45444-5400			IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466 Telephone (703) 756-2340 AUTOVON 289-2340		